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MONTHLY WEIGHT AND BALANCE REPORT

FOR THE APOLLO SPACECRAFT

CONTRACT NAS 9-150

(U)

PARAGRAPH 8.10 EXHIBIT I

1 MAY 1964



Prepared by

Weight Control

CLASSIFICATION CHANGE

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NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

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~~CONFIDENTIAL~~INTRODUCTION

The May Report continues to utilize the current Airframe 011 drawing release as a basis. The current weight status summarizes the changes from the previous Airframe 011, and incorporates the estimated changes for the LOR Mission Spacecraft. This format allows weight status reporting consistent with airframe release and continuous updating of the estimated LOR changes. The Potential Weight Changes Section includes the current design changes plus Block II changes.

The current report reflects a LOR spacecraft decrease of 95 pounds at injection and 45 pounds at the injected spacecraft condition less Service Module propellant. The current injected weight of 90,115 pounds is based on Service Module propellant loading for a specific impulse of 313.0 seconds, and ΔV budget of the MSC Letter PE 5-64-78, dated approximately 11 February 1964, subject Contract NAS 9-150, Velocity Budget, Target Weight and Mission Plans. This is based on a lunar excursion module of 29,500 pounds, excluding crew.

The major changes in the Command Module were due to incorporating the Block II Guidance and Navigation System along with deleting the spares and reflecting an optimized airframe - Earth Landing System.

The major changes in the Service Module were due to increases in structure based on new honeycomb bond requirements and added stiffening required by new helium bottle dynamic loads.

The major change in the Launch Escape System was due to a decrease in ballast consistent with the combined Launch Escape and Command Module balance requirement.

The Earth Orbital Mission Weight Summary reflects a two state Booster-to-Orbit injection without the use of Service Module propulsion and is based on a complete Service Module with 2,430 pounds of deorbit propellant. The Earth Orbit weight reported limits the orbital altitude capability with the Saturn I booster to 60.4 nautical miles. To obtain the 100 nautical mile orbital altitude with the Saturn I booster requires offloading items from the Command Module and Service Module.

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APOLLO LOR MISSION

WEIGHT, CENTER OF GRAVITY AND INERTIA SUMMARY

ITEM	WEIGHT POUNDS	CENTER OF GRAVITY*			MOMENTS OF INERTIA (SLUG-FT. ²)		
		X	Y	Z	ROLL (X)	PITCH (Y)	YAW (Z)
COMMAND MODULE	10050	1043.4	0.6	6.2	4763	4203	3896
SERVICE MODULE - Less Propellant	10120	906.9	0.6	-0.3	6471	10721	10601
TOTAL - Less Propellant	20170	974.9	0.6	2.9	11280	35249	34776
PROPELLANT - S/M**	36970	905.6	5.9	-2.5	18963	19732	26180
TOTAL - With Propellant	57140	930.1	4.0	-0.6	30405	68597	74568
LUNAR EXCURSION MODULE	29500	588.5	-0.5	-0.3	19409	21485	21219
ADAPTER - LEM - C-5	3475	657.0	0.0	0.0	8504	11778	11778
TOTAL - Injected	90115	807.7	2.4	-0.5	58410	609512	615307
LAUNCH ESCAPE SYSTEM	7585	1305.2	0.0	0.0	290	14864	14867
TOTAL - SPACECRAFT LAUNCH	97700	846.3	2.2	-0.4	58709	998094	1003901

NOTES: *Centers of gravity are in the NASA reference system except that the longitudinal axis has an origin 1000 inches below the tangency point of the command module substructure mold line.

**The propellant weight of 36970 pounds is determined from an estimated time line analysis. The propellant weight is based on a specific impulse of 313.0.

APOLLO EARTH ORBIT MISSION

WEIGHT, CENTER OF GRAVITY AND INERTIA SUMMARY

ITEM	WEIGHT POUNDS	CENTER OF GRAVITY*			MOMENTS OF INERTIA (SLUG-FT. ²)		
		X	Y	Z	ROLL (X)	PITCH (Y)	YAW (Z)
COMMAND MODULE	10050	1043.4	0.6	6.2	4763	4203	3896
SERVICE MODULE - Less Propellant	10120	900.9	0.6	-0.3	6471	10721	10601
TOTAL - Less Propellant	20170	974.9	0.6	2.9	11280	35249	34776
PROPELLANT - S/M**	2430	848.9	27.3	-11.5	809	440	559
TOTAL - With Propellant	22600	961.4	3.5	1.4	12520	43220	43102
ADAPTER - C-1	885	778.5	-0.3	-0.5	1058	868	820
TOTAL - Injected	23485	954.5	3.3	1.3	13582	50235	50071
LAUNCH ESCAPE SYSTEM	7585	1305.2	0.0	0.0	290	14864	14867
TOTAL - Spacecraft Launch	31070	1040.1	2.5	1.0	13887	217325	217175

NOTES: *Centers of gravity are in the NASA reference system except that the longitudinal axis has an origin 1000 inches below the tangency point of the command module substructure mold line.

**The earth orbital weights are based on a complete service module and includes 2430 pounds of propellant for an orbital altitude of about 60.4 nautical miles with a payload launch azimuth of 72°.

APOLLO LAUNCH ABORT CONFIGURATION
WEIGHT, CENTER OF GRAVITY AND INERTIA SUMMARY

ITEM	WEIGHT POUNDS	CENTER OF GRAVITY*			MOMENTS OF INERTIA (SLUG-FT. ²)		
		X	Y	Z	ROLL (X)	PITCH (Y)	YAW (Z)
COMMAND MODULE	10050	1043.4	0.6	6.2	4763	4203	3896
LAUNCH ESCAPE SYSTEM	7585	1305.2	0.0	0.0	290	14864	14867
TOTAL - Launch Abort	17635	1156.0	0.3	3.5	5089	83050	82711
LESS - MAIN AND PITCH MOTOR PROPELLANTS	-3190	1296.2	0.0	0.0	-69	-1288	-1288
TOTAL - LES Burnout	14445	1125.0	0.4	4.3	5010	65230	64901

NOTES: *Centers of gravity are in the NASA reference system except that the longitudinal axis has an origin 1000 inches below the tangency point of the command module substructure mold line.

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COMMAND MODULE

WEIGHT, CENTER OF GRAVITY AND INERTIA SUMMARY

LUNAR ORBIT RENDEZVOUS MISSION

VEHICLE MODE	WEIGHT POUNDS	CENTER OF GRAVITY			MASS INERTIA DATA (SLUG-FT. ²)						
		X	Y	Z	Ixx	Iyy	Izz	Ixy	Ixz	Iyz	
COMMAND MODULE, LAUNCH	10050	1043.4	0.6	6.2	4763	4203	3896	-8	-213	-46	
ADJUSTMENTS (NET)	-52										
Boost & Mission Coolants											
Food & Water Consumption											
Mission Waste Pickup											
Fuel Cell Water Pickup											
Docking Provisions											
Ablator B/O, Boost											
PRIOR TO ENTRY	9998	1042.3	0.7	6.4	4761	4123	3811	5	-226	-43	
Less: Propellant	-135	1022.6	-5.1	56.6							
Ablator Burnoff	-240	1024.4	0.0	12.5							
Entry Coolant	-6	1022.6	-63.4	-16.4							
Forward Heat Shield	-336	1098.3	-0.1	3.4							
Drogue Chutes	-50	1090.0	0.0	-22.0							
PRIOR TO MAIN CHUTE DEPLOYMENT	9231	1040.8	0.8	5.8	4414	3584	3332	4	-168	-36	
Less: Main Chutes (3)	-382	1091.0	-0.7	7.7							
Propellant	-135	1022.6	-5.1	56.6							
LANDING	8714	1038.9	1.2	4.9	4266	3214	2995	8	-152	-27	

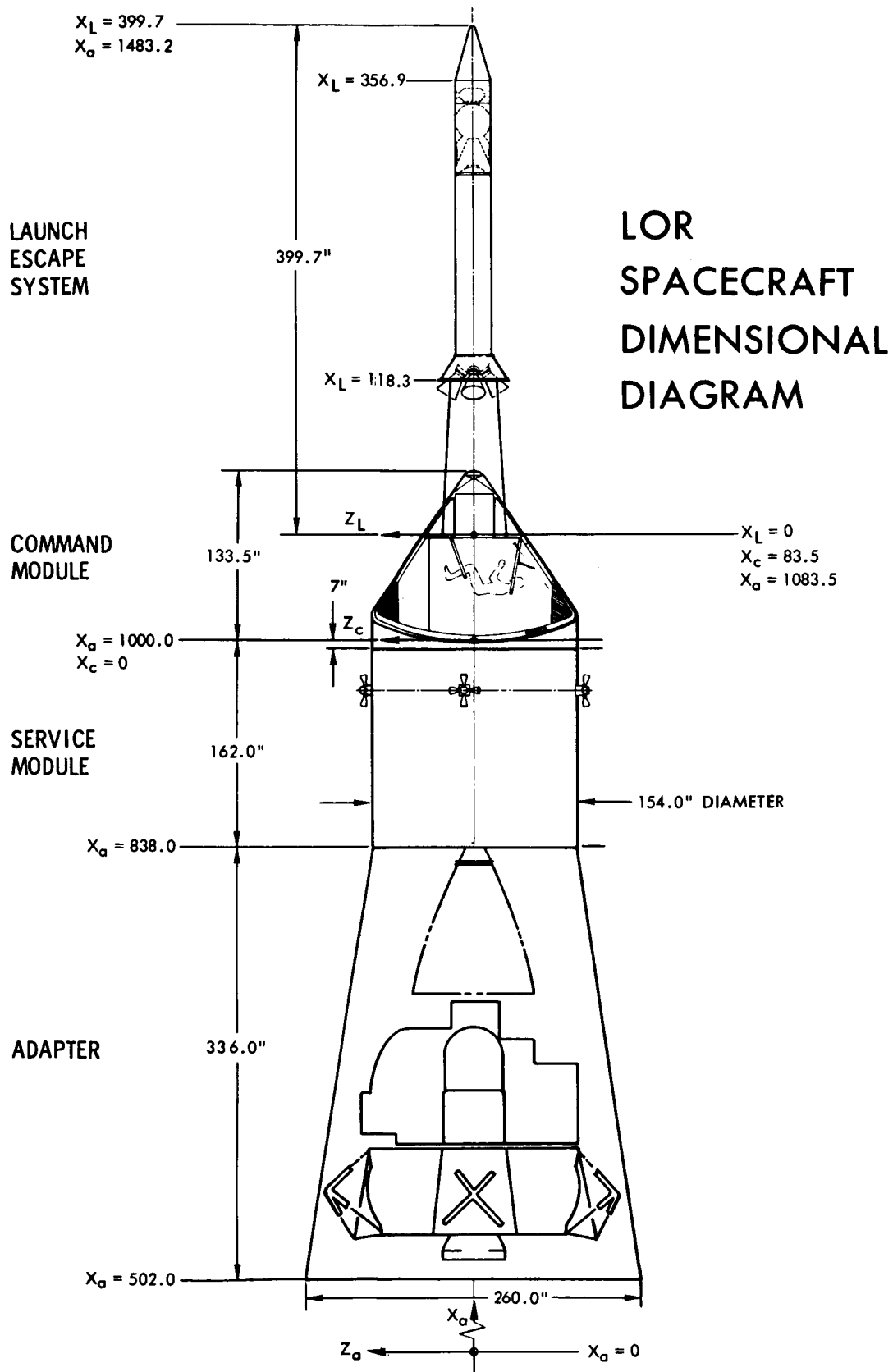
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COMMAND MODULE

WEIGHT, CENTER OF GRAVITY AND INERTIA SUMMARY

LOW ALTITUDE ABORT CONDITION

VEHICLE MODE	WEIGHT POUNDS	CENTER OF GRAVITY			MASS INERTIA DATA (SLUG-FT. ²)					
		X	Y	Z	Ixx	Iyy	Izz	Ixy	Ixz	Iyz
COMMAND MODULE, LAUNCH	10050	1043.4	0.6	6.2	4763	4203	3896	-8	-213	-46
Less: Oxidant	-180	1022.6	15.6	62.4						
Forward Heat Shield	-336	1098.3	-0.1	3.4						
Docking Provisions	-100	1110.0	0.0	0.0						
Drogue Chute	-50	1090.0	0.0	-22.0						
PRIOR TO MAIN CHUTE DEPLOYMENT	9384	1040.9	0.3	5.4	4546	3659	3470	7	-137	-78
Less: Main Chutes (3)	-382	1091.0	-0.7	7.7						
Fuel	-90	1022.6	-46.5	44.9						
LANDING	8912	1038.9	0.9	4.9	4427	3340	3118	-4	-134	-43

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~~CONFIDENTIAL~~SPACECRAFTWEIGHT STATUS SUMMARY(LESS LEM)

ITEM	PREVIOUS AFRM O11 STATUS 4-1-64	CHANGE TO CURRENT AFRM	CURRENT AFRM O11 WEIGHT 5-1-64	ESTIMATED CHANGES TO LOR	CURRENT LOR WEIGHT 5-1-64	BASIS FOR CURRENT LOR STATUS		
						%EST	%CAL	%ACT
COMMAND MODULE	10440	-60	10380	-330	10050	42	58	
SERVICE MODULE - B/O	9880	+70	9950	+170	10120	17	73	10
LES	7500	-	7500	+85	7585	44	50	6
ADAPTER	885		885	+2590	3475	100		
TOTAL LESS PROPELLANT	28705	+10	28715	+2515	31230	41	54	5
PROPELLANT	-	-	-	-	36970		100	
GROSS WEIGHT	-	-	-	-	68200	19	79	2

INJECTED SPACECRAFTWEIGHT STATUS

ITEM	PREVIOUS LOR STATUS 4-1-64	CHANGE TO CURRENT	CURRENT LOR STATUS 5-1-64
COMMAND MODULE	10200	-150	10050
SERVICE MODULE	10015	+105	10120
ADAPTER	3475		3475
LEM	29500		29500
TOTAL S/C Injected Less Propellant	53190	-45	53145
PROPELLANT	37020	-50	36970
TOTAL INJECTED WEIGHT	90210	-95	90115

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COMMAND MODULE WEIGHT STATUS

ITEM	PREVIOUS AFRM OLL STATUS 4-1-64	CHANGES TO CURRENT AFRM	CURRENT AFRM OLL WEIGHT 5-1-64	ESTIMATED CHANGES TO LOR	CURRENT LOR WEIGHT 5-1-64	BASIS FOR CURRENT LOR STATUS		
						%EST	%CAL	%ACT
Structure Structure - Less Ablator Ablation Material	(4762) 3409 1353	(+30) +30	(4792) 3439 1353	(-65) +15 -80	(4727) 3454 1273	15 100	85	
Stabilization & Control	248		248	-22	226	14	86	
Guidance & Navigation	459	-81	378	-21	357	45	55	
Crew Systems	442	+5	447	-20	427	14	86	
Environmental Control	311	+1	312	-14	298	33	59	8
Earth Landing System	704	-77	627		627	78		
Instrumentation	622	-22	600	-338	262	35	65	
Electrical Power	590	+5	595	-15	580	83	17	
Reaction Control	332		332	-2	330	62	38	
Communications	369	+1	370	-8	362	35	65	
Controls & Displays	343	+2	345	-27	318	21	78	
WEIGHT EMPTY	9182	-136	9046	-532	8514	42	58	
Scientific Equipment	-	-	-	+250	250	100		
Crew Systems	846	+77	923	-48	875	39	61	
Reaction Control	270		270		270		100	
Environmental Control	142	-1	141		141		100	
GROSS WEIGHT	10440	-60	10380	-330	10050	42	58	

**~~CONFIDENTIAL~~**COMMAND MODULECURRENT AIRFRAME WEIGHT EMPTY CHANGESSTRUCTURE

(+30.0)

Increase secondary structure based on definition of subsystems causing modification of honeycomb panels and adding supports to accommodate these subsystems as follows:

+24.0

Increase in right hand equipment bay due to panel redesign to accommodate electrical and environmental control systems. +6.0

Increase in left hand equipment bay due to addition of supports and redesign to remove an installation interference. +4.0

Increase in main display panel due to the addition of filler in the honeycomb panels for equipment supports and panel redesign for electrical provisions. +4.0

Increase in lower equipment bay panels due to redesign for equipment installation and replacement of potted inserts with aluminum inserts. +3.0

Increase in aft equipment bay due to incorporating provisions for two portable life support systems. +2.0

Increase in heat shield equipment area due to addition of electrical supports and brackets for flight qualification instrumentation. +5.0

Decrease heat shield substructure forward section attaching parts based on calculation of released drawings. -2.0

Increase heat shield substructure center section due to adding an aluminum plate to the sextant door to prevent deflection. +4.0

Increase heat shield substructure aft section based on calculation of released drawing reflecting an increase in the aft moment tie. +4.0

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~~CONFIDENTIAL~~COMMAND MODULECURRENT AIRFRAME WEIGHT EMPTY CHANGESGUIDANCE & NAVIGATION

(-81.0)

Decrease Guidance and Navigation system due to the deletion of spares which are not required for the Block I system due to unmanned or short duration flights.

-81.0

CREW SYSTEMS

(+5.0)

Increase crew couch pads based on calculation of released drawings reflecting higher density material than previously indicated.

+4.0

Increase water delivery assembly due to addition of metering capability to the potable water supply to provide accurate measurements for food rehydratability.

+1.0

ENVIRONMENTAL CONTROL

(+1.0)

Increase waste management system due to incorporation of vendor estimates.

+3.8

Delete the re-entry back-up oxygen system as this requirement does not exist when the spacecraft equipment includes a portable life support system.

-3.0

Increase oxygen system plumbing based on calculation of drawing changes which update system to current requirements.

+1.0

Decrease supports based on calculation of drawings reflecting current system requirements.

-.8

EARTH LANDING SYSTEM

(-77.0)

Decrease drogue chute system due to the utilization of steel cable risers in lieu of nylon, allowing a reduction of the protective ring around the mortar muzzle.

-7.4

Decrease pilot chute system due to reducing pilot chute diameter from 10 feet to 7.2 feet and redesign of pilot mortar assembly to conform to smaller volume, required by smaller chute per Northrop Ventura test results.

-5.8

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**~~CONFIDENTIAL~~**COMMAND MODULECURRENT AIRFRAME WEIGHT EMPTY CHANGESEARTH LANDING SYSTEM (Cont'd)

Decrease main cluster assembly due to the following changes reported by Northrop Ventura:	-59.0
Decrease in Main Chute pack due to shortened risers and optimized design to use lighter material based on reduced opening loads.	-40.7
Decrease in harness and disconnect due to redesign utilize steel cables in lieu of nylon straps, titanium confluence and deck fittings in lieu of steel fittings, and a light felt and nylon covering in lieu of former thermo-fit covering.	-20.7
Addition of insulation to cover chute packs per revised heating rates.	+2.4
Decrease in parachute system attach provisions for the main and drogue chute attachment based on calculated in lieu of estimated weights.	-4.8

INSTRUMENTATION

(-22.0)

Decrease inflight test system due to reducing comparators from 150 to 72 per current system requirements.	-24.0
Increase instrumentation electrical provisions based on current estimates.	+2.0

ELECTRICAL POWER

(+5.0)

Decrease pyrotechnic battery based on vendor weight information.	-2.0
Increase wiring provisions due to the addition of control provision for the cryogenic fan heaters in the service module.	+5.0
Increase umbilical based on calculation of current released drawings.	+2.0

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~~CONFIDENTIAL~~COMMAND MODULECURRENT AIRFRAME WEIGHT EMPTY CHANGESCOMMUNICATION (+1.0)

Increase multiplexer due to the addition of a UHF channel which has been required since the addition of the up-data link.

+1.0

CONTROLS AND DISPLAYS (+2.0)

Increase entry monitor display based on revised vendor estimate per Autonetics status.

+8.0

Increase G & N computer keyboard per MIT status reflecting actual in lieu of calculated weights.

+1.0

Increase G & N lower equipment bay computer control per MIT status reflecting actual in lieu of calculated weights.

+1.0

Decrease caution and warning detection due to deleting spares not required for reliability and removal of two detector modules along with repackaging of unit.

-8.0

TOTAL COMMAND MODULE CURRENT AIRFRAME WEIGHT EMPTY CHANGES

-136.0

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~~CONFIDENTIAL~~COMMAND MODULECURRENT AIRFRAME USEFUL LOAD CHANGESCREW SYSTEMS

(+77.0)

Add two portable life support systems to the early spacecrafts due to the requirement that all manned flights without the LEM must carry two PLSS's in the Command Module.

+84.0

Decrease survival kit containers based on calculation of current released drawings.

-7.0

ENVIRONMENTAL CONTROL

(-1.0)

Decrease re-entry oxygen due to removal of the separate re-entry backup oxygen tank which is not required when the spacecraft equipment includes a portable life support system.

-1.0

TOTAL COMMAND MODULE CURRENT AIRFRAME USEFUL LOAD CHANGES

+76.0

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SERVICE MODULE WEIGHT STATUS

ITEM	PREVIOUS AFRM OLL STATUS 4-1-64	CHANGES TO CURRENT AFRM	CURRENT AFRM OLL WEIGHT 5-1-64	ESTIMATED CHANGES TO LOR	CURRENT LOR WEIGHT 5-1-64	BASIS FOR CURRENT LOR STATUS		
						%EST	%CAL	%ACT
Structure	2225	+80	2305	+75	2380	9	76	15
Environmental Control	170		170	-80	90	12	87	1
Instrumentation	132	-2	130	+2	132	26	74	
Electrical Power	1434	+2	1436	+13	1449	15	34	51
Propulsion System Engine Installation	(3064) 712	(+15) +15	(3079) 727		(3079) 727	50	50	
Propulsion System	2352		2352		2352	13	87	
Reaction Control	601	-25	576		576	61	39	
Communications & Rendezvous Radar	24		24	+160	184	100		
WEIGHT EMPTY	7650	+70	7720	+170	7890	21	65	14
RCS Propellant	838		838		838		100	
Electrical Power Super. Fluids	503		503		503		100	
Environmental Contr. Super. Fluids	208		208		208		100	
Main Propulsion Helium	99		99		99		100	
Main Propulsion Residuals Trapped - System	(582) 225		(582) 225		(582) 225		100	
Trapped - Engine	67		67		67			
Mixture Ratio Tolerance	100		100		100			
Loading Tolerance	190		190		190			
BURNOUT WEIGHT	9880	+70	9950	+170	10120	17	73	10
Main Propellant					36970		100	
GROSS WEIGHT					47090	4	94	2

~~CONFIDENTIAL~~SERVICE MODULECURRENT AIRFRAME WEIGHT EMPTY CHANGES

<u>STRUCTURE</u>	(+88.0)
Increase internal partitions due to adding stiffeners and increasing inner skin thickness based on new dynamic loads from the helium bottles.	+12.0
Increase structure due to new bond requirements based on revised specification which increases the bond at all honeycomb core edges.	+68.0
<u>INSTRUMENTATION</u>	(-2.0)
Decrease electrical provisions based on current wire estimates.	-2.0
<u>ELECTRICAL POWER</u>	(+2.0)
Increase cryogenic electrical wiring due to revising the cryogenic tank heater design to incorporate a fan heater that requires additional wiring for AC power.	+5.0
Decrease the cryogenic hydrogen and oxygen tanks due to redesigning the tanks to remove the internal spherical heaters and replace them with a heater and fan installation which helps to acquire the cleanliness level required for the fuel cells and provide a controlled temperature within a specified tolerance to maintain the accuracy of the quantity gauging system.	-16.4
Increase the cryogenic tanks due to a thermal heat leak problem which requires an increased outer shell gauge as reported in a current Beech status.	+15.0
Decrease umbilical based on calculation of current released drawings.	-1.6
<u>MAIN PROPULSION</u>	(+15.0)
Increase engine based on Aerojet status reflecting a redesign of the fuel and oxidizer valves.	+15.0
<u>REACTION CONTROL</u>	(-25.0)
Decrease propellant system quantity gauging based on vendor status reflecting a reduction of sensor component weights.	-5.0

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~~CONFIDENTIAL~~SERVICE MODULECURRENT AIRFRAME WEIGHT EMPTY CHANGESREACTION CONTROL (Cont'd)

Decrease engine system reflectors and insulation based on test reports that show the increase in reflectors and insulation reported in the March report for the 500 second continuous burning is not required.

-20.0

TOTAL SERVICE MODULE CURRENT AIRFRAME WEIGHT EMPTY CHANGES

+70.0

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~~CONFIDENTIAL~~LAUNCH ESCAPE SYSTEMWEIGHT STATUS

ITEM	PREVIOUS AFRM O11 STATUS 4-1-64	CHANGE TO CURRENT AFRM	CURRENT AFRM O11 WEIGHT 5-1-64	ESTIMATED CHANGES TO LOR	CURRENT LOR WEIGHT 5-1-64	BASIS FOR CURRENT LOR STATUS		
						%EST	%CAL	%ACT
Structure	1314		1314		1314	42	58	
Electrical System	85		85		85	5	95	
Propulsion System								
Main Thrust	4767	+7	4774		4774	40	60	
Jettison	434		434		434			100
Jettison Motor								
Skirt	92		92		92			100
Pitch Control	47	+2	49		49	60	40	
Separation Provisions	13		13		13		100	
C/M Boost Prot. Cover				+185	185	100		
LES - NO BALLAST	6752	+9	6761	+185	6946	39	54	7
BALLAST	748	-9	739	-100	639	100		
TOTAL L.E.S	7500	-	7500	+85	7585	44	50	6

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(+9)

Increase escape motor due to addition of chamber liner to increase the safety margin and added structural material behind nozzle throats per Lockheed propulsion status.

+7

Increase pitch control motor based on Lockheed propulsion status reflecting partial actual weights.

+2

BALLAST

(-9)

Decrease ballast consistent with current Command Module and LES balance requirements

-9

TOTAL LAUNCH ESCAPE SYSTEM CURRENT AIRFRAME WEIGHT CHANGES

-

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ITEM	PREVIOUS AFRM O11 STATUS 4-1-64	CHANGE TO CURRENT AFRM	CURRENT AFRM O11 WEIGHT 5-1-64	ESTIMATED CHANGE TO LOR	CURRENT LOR WEIGHT 5-1-64	BASIS FOR CURRENT LOR STATUS		
						%EST	%CAL	%ACT
Structure	709		709	+2362	3071			
Electrical	20		20	+50	70			
Separation System	156		156	+178	334			
TOTAL ADAPTER	885		885	+2590	3475	100		

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**~~CONFIDENTIAL~~**COMMAND MODULECURRENT ESTIMATED WEIGHT EMPTY CHANGES TO LOR

STRUCTURE	(-65.0)
Eliminate the heat shield substructure face sheet pads (scar weight) provided on the first few spacecrafts for designs that were not consummated (strakes, plugs, vents, etc.).	-26.0
Analyze structure design in detail based on a refinement of loading conditions, as the original design was accomplished on an extremely tight schedule, utilizing a minimum of loads and equipment information.	-40.0
Incorporate a boost protection cover over the Command Module nose to be jettisoned with the Launch Escape System tower. This would allow the ablative material thickness on the nose to be reduced.	-30.0
Reduce the spacecraft temperature criteria from 250°F to 200°F. A saving of approximately one pound of ablative material can be removed for every degree reduction at start of entry.	-50.0
Refine secondary structure design by additional machining of extrusions utilized in coldplate closeouts, alternate materials, and a reduction of supports for scientific equipment.	-60.0
Reduce heat shield window glass thickness from 0.70 inch to 0.55 inch based on a more detailed thermal and structural analysis.	-10.0
Add LEM docking provisions for the LOR mission.	+150.0
Add lower equipment bay supports required for food compartments which were accomplished on Airframe 011 by a food storage box designed by Crew Systems.	+8.0
Decrease secondary structure heatshield equipment area due to removing supports which are installed in the early Airframe for support of flight qualification equipment.	-4.0
Decrease the heatshield substructure due to enlarging the umbilical from 1100 to 1300 wires which requires a larger cutout in the heatshield.	-3.0

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~~CONFIDENTIAL~~COMMAND MODULECURRENT ESTIMATED WEIGHT EMPTY CHANGES TO LOR

	(-22.0)
<u>STABILIZATION AND CONTROL</u>	
Remove all elapsed time indicators prior to flight.	-1.0
Utilized partial potting in low dissipation ECA modules.	-5.0
Reduce total length of ECA package. Packages are presently designed to include growth capabilities.	-3.0
Delete multiple monitor relays in DC amplifiers.	-1.0
Decrease electrical wiring due to utilizing thin wall teflon insulation where possible and reducing wire gage based on electrical load analysis.	-12.0
<u>GUIDANCE AND NAVIGATION</u>	(-21.0)
Decrease electrical wiring due to utilizing thin wall teflon insulation where possible and reducing wire gage based on electrical load analysis.	-8.0
Decrease guidance and navigation system due to incorporating the Block II G & N system for the lunar spacecraft,	-13.0
<u>CREW SYSTEMS</u>	(-20.0)
Decrease food storage boxes as the design for the LOR vehicle will be accomplished by the secondary structure supports in lieu of using a removable stowage as is used on Airframe 011.	-20.0
<u>ENVIRONMENTAL CONTROL</u>	(-14.0)
Utilize a combined tank with separate compartments for waste water and potable water.	-4.0
Delete provisions for Service Module temperature control system as the requirements for the LOR vehicle have not been thoroughly defined at this time.	-10.0
<u>INSTRUMENTATION</u>	(-338.0)
Delete instrumentation required for flight qualification.	-305.0

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~~CONFIDENTIAL~~COMMAND MODULECURRENT ESTIMATED WEIGHT EMPTY CHANGES TO LORINSTRUMENTATION (Cont.)

Decrease electrical wiring due to utilizing thin wall teflon insulation where possible, reducing wire gage based on electrical load analysis and reducing instrumentation wiring by utilizing unshielded wire where possible. -34.5

Add Nuclear Radiation Detection required for the lunar vehicle. +1.5

ELECTRICAL POWER

(-15.0)

Increase electrical common utility due to increasing the capacity of the C/M to S/M umbilical from 1100 wires to 1300 wires required for lunar vehicle. +16.0

Delete the sequencer system required to perform separation of the spacecraft from the booster during normal spacecraft-booster separation or a service propulsion system abort situation as this system is required for earth orbit missions only. -12.0

Decrease electrical wiring due to utilizing thin wall teflon insulation where possible and reducing wire gage based on electrical load analysis. -19.0

REACTION CONTROL

(-2.0)

Decrease electrical wiring due to utilizing thin wall teflon insulation where possible and reducing wire gage based on electrical load analysis. -2.0

COMMUNICATIONS

(-8.0)

Decrease electrical wiring due to utilizing thin wall teflon installation where possible and reducing wire gage based on electrical load analysis. -8.0

CONTROLS AND DISPLAYS

(-27.0)

Reduce weight of displays by utilizing lamps in lieu of the barometric pressure indicator and by sharing cryogenic pressure and quantity readouts between the hydrogen and oxygen requirements. -4.0

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~~CONFIDENTIAL~~COMMAND MODULECURRENT ESTIMATED WRIGHT EMPTY CHANGES TO LORCONTROLS AND DISPLAYS (Cont.)

Delete the self-test capability of the SCS displays.	-2.0
Chem-etch mounting panels for the LOR vehicles that could not be accomplished due to schedule on Airframe Oll.	-3.5
Delete present reaction jet solenoid power switching relays from the SCS mode select panel. Utilize a manual switch and circuit breakers for reaction jet solenoid power control.	-2.0
Decrease lower equipment bay G & N controls and displays due to incorporating the Block II G & N system for the lunar spacecraft.	-1.6
Replace roll attitude error needle servo drive with galvanometer movement.	-1.0
Add rendezvous radar panel required for LOR mission.	+13.0
Delete console interface connectors resulting in some complications in manufacturing and repair of console.	-9.0
Decrease electrical wiring due to utilizing thin wall teflon insulation where possible and reducing wire gage based on electrical load analysis.	-15.4
Add Nuclear Radiation Display required for the lunar vehicle that was previously assumed to be on Airframe Oll.	+1.5
Delete Service Module temperature control panel as the requirements for the LOR vehicle have not been thoroughly defined at this time.	-3.0
<hr/>	
TOTAL COMMAND MODULE CURRENT ESTIMATED WEIGHT EMPTY CHANGES TO LOR	-532.0

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~~CONFIDENTIAL~~COMMAND MODULECURRENT ESTIMATED USEFUL LOAD CHANGES TO LORSCIENTIFIC EQUIPMENT

(+250.0)

Add scientific equipment based on current LOR mission requirements.

+250.0

CREW SYSTEM

(-48.0)

Delete one portable life support system as the requirement on the LOR vehicle with the LEM is for only one.

-42.0

Decrease hygiene and medical storage boxes based on redesign of containers that cannot be accomplished on Airframe Oll,

-6.0

TOTAL COMMAND MODULE CURRENT ESTIMATED USEFUL LOAD CHANGES TO LOR +202.0

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~~CONFIDENTIAL~~SERVICE MODULECURRENT ESTIMATED WEIGHT EMPTY CHANGES TO LOR

<u>STRUCTURE</u>	(+80.0)
Add structural beef-up required to support the rendezvous radar equipment.	+40.0
Add structural provisions for supporting the high gain antenna, previously assumed to be on Airframe Oll.	+30.0
Increase structural provision for the C/M to S/M umbilical fairing due to enlarging the capacity from 1100 to 1300 wires.	+10.0
<u>ENVIRONMENTAL CONTROL</u>	(-80.0)
Delete Service Module temperature control system as the requirements for the LOR vehicle have not been thoroughly defined at this time.	-80.0
<u>INSTRUMENTATION</u>	(+2.0)
Add radiation detection sensors to the Service Module due to changing to a system which senses proton bombardment only.	+2.0
<u>ELECTRICAL POWER</u>	(+13.0)
Increase C/M to S/M umbilical due to enlarging from capacity from 1100 wires to 1300 wires.	+13.0
<u>COMMUNICATIONS & RENDEZVOUS RADAR</u>	(+160.0)
Add high gain antenna required for deep space communications. This item was previously assumed to be in Airframe Oll.	+40.0
Add rendezvous radar equipment consistent with the LOR Requirements.	+120.0
 TOTAL SERVICE MODULE ESTIMATED WEIGHT EMPTY CHANGES TO LOR	 +175.0

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~~CONFIDENTIAL~~LAUNCH ESCAPE SYSTEMCURRENT ESTIMATED WEIGHT CHANGES TO LORSTRUCTURE

(+185)

Add a boost heat shield for protection of the forward compartment during boost heating. The addition of the boost heat shield reduces the forward compartment heat shield ablative thickness and lightens the injected spacecraft weight.

+185

BALLAST

(+100)

Decrease ballast consistent with current Command Module LES balance requirements.

-100

TOTAL LAUNCH ESCAPE SYSTEM CURRENT ESTIMATED WEIGHT CHANGES TO LOR

+85

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~~CONFIDENTIAL~~ADAPTERCURRENT ESTIMATED WEIGHT CHANGES TO LOR

Utilize the S-IV B Adapter consistent with the current LOR
mission requirements in lieu of the S-IV Airframe 011
Adapter

+2515

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~~CONFIDENTIAL~~WEIGHT HISTORY COMMENTS

LAUNCH ESCAPE SYSTEM

The design goal established for the LES is 6,300 pounds, excluding ballast. This weight was based on the September 1962 status weight of 6,600 pounds, including the necessary ballast to provide currently determined aerodynamic stability to prevent tumbling.

The original design goal of 5,900 pounds, as reported in the June status, S&ID 62-99-5, was based on an attitude controlled configuration. The current configuration weight includes a pitch motor and ballast not included in the original target weight.

COMMAND MODULE

The design goal established for the Command Module is 8,500 pounds. An estimated weight breakdown for the design goal is provided for comparative purposes.

The original design goal weight of 8,340 pounds, as reported in the June status, S&ID 62-99-5, did not include the proposed increases nor the Category I reductions presented in the July briefing and incorporated in the July Status Report.

SERVICE MODULE

The design goal established for the Service Module less usable propellant is 11,000 pounds. An estimated weight breakdown for the design goal is provided for comparative purposes. This configuration is sized for 45,000 pounds usable propellant for the 25,000 pound LEM.

The original design goal weight of 8,595 for the burnout condition was based on lunar configuration sized for 31,000 pounds usable propellant.

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~~CONFIDENTIAL~~WEIGHT HISTORYCOMMAND MODULE

ITEM	DESIGN GOAL	AUTHORIZED CHANGES	5-1-64 DESIGN GOAL ADJUSTED
Structure	3824	+277	4101
Stabilization & Control	181		181
Guidance & Navigation	261	+86	347
Crew System	530		530
Environmental Control	235	-11	224
Earth Landing System	610		610
Instrumentation	173	+7	180
Electrical Power	390	+9	399
Reaction Control	195		195
Communication	330	+33	363
Controls & Displays	261	+19	280
WEIGHT EMPTY	6990	+420	7410
Scientific Equipment	250		250
Crew	528		528
Suits & Personal Equipment	304	-8	296
Food & Containers	90		90
Reaction Control Propellant	210		210
Environmental Control Fluids	128		128
GROSS WEIGHT	8500	+412	8912

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~~CONFIDENTIAL~~COMMAND MODULE WEIGHT HISTORYWEIGHT EMPTY AUTHORIZED CHANGES

STRUCTURE	(+277)
Change parachute attach to a two leg configuration for incorporation of the "Tumbling Concept" at earth impact attenuation. (CCA No. 93)	+125
Delete the extendable heat shield window covers and replace current windows with high temperature glass consisting of (3) parallel glass panes. (CCA No. 105)	+2
Add LEM docking provisions for LOR.	+150
GUIDANCE & NAVIGATION	(+86)
Increase the Guidance and Navigation per recent weight report from MIT. Since NAA does not have weight control responsibility for the MIT design, the weight changes in their Weight and Balance Report will be considered as authorized changes.	+86
ENVIRONMENTAL CONTROL	(-11)
Add a CO ₂ sensor to the ECS as a part of the ECS operational instrumentation. (CCA No. 43)	+2
Add a surge tank to ECS and delete entry oxygen supply to provide early mission emergency gas flows. (CCA No. 52)	-7
Deletion of regenerative heat exchanger from the ECS heat exchanger package. (CCA No. 63)	-7
Decrease pressure suit gas flow requirement for ventilation flow from 12 CFM to 10 CFM. (CCA No. 123)	+1
INSTRUMENTATION	(+7)
Increase the PCM output bit rate from 31,000 to 51,200 bit/sec. This change was originally considered to have negligible weight affect but has henceforth been reported by Collins to cause a seven pound increase. (CCA No. 44)	+7

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~~CONFIDENTIAL~~COMMAND MODULE WEIGHT HISTORYWEIGHT EMPTY AUTHORIZED CHANGES

ELECTRICAL POWER	(+9)
Add two batteries to provide a source of power, separate from the primary D.C. power, to initiate pyrotechnic devices. (CCA No. 28)	+10
Delete automatic LES Tower ejection function from flight sequencer for normal missions. (CCA No. 91)	-1
COMMUNICATIONS	(+33)
Add a spacecraft up-data link for the purpose of providing current GOSS data within the spacecraft for display and comparison with the on-board computed data. (CCA No. 54)	+35
Change the present two speed data storage to a three speed machine to provide fast dump of data. (CCA No. 59)	-2
CONTROLS & DISPLAYS	(+19)
Furnish and install a clock timer panel at the navigation station lower equipment bay. (CCA No. 84)	+2
Increase G&N navigation controls coded to controls and displays per MIT status.	+4
Add rendezvous radar for LOR.	+13
TOTAL COMMAND MODULE WEIGHT EMPTY CHANGES	+420

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~~CONFIDENTIAL~~COMMAND MODULE WEIGHT HISTORYUSEFUL LOAD AUTHORIZED CHANGES

SUITS & PERSONAL EQUIPMENT

(-8)

Change the following GFE (NASA) responsibility items:

Increase personal radiation dosimeters per NASA Crew Systems Meeting Number 19, Action Item Number 6.	+10
Increase PLSS per Hamilton Standard status.	+36
Delete initial charge water for coolant, from PLSS, as this item is now carried in the potable water tank.	-5
Delete one PLSS consistent with requirements for LOR mission.	-48
Delete primary oxygen from remaining PLSS.	-1

TOTAL COMMAND MODULE USEFUL LOAD CHANGES

-8~~CONFIDENTIAL~~

**~~CONFIDENTIAL~~**WEIGHT HISTORYSERVICE MODULE

ITEM	DESIGN GOAL	AUTHORIZED CHANGES	5-1-64 DESIGN GOAL ADJUSTED
Structure	3203	+40	3243
Environmental Control	250		250
Instrumentation	100		100
Electrical Power	1203		1203
Propulsion System			
Engine Installation	606		606
Propellant System	2456		2456
Reaction Control	737		737
Communications & Rendezvous Radar	45	+120	165
WEIGHT EMPTY	8600	+160	8760
Usable RCS Propellant	611		611
Usable Fuel Cell Reactants	479		479
Environmental Control Fluids	193		193
Main Propulsion Helium	139		139
Main Prop. Residuals	900		900
Unusable RCS Propellant	61		61
Unusable Fuel Cell Reactants	17		17
BURNOUT WEIGHT	11000	+160	11160
Main Propellant	45000		45000
GROSS WEIGHT	56000	+160	56160

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~~CONFIDENTIAL~~SERVICE MODULE WEIGHT HISTORYWEIGHT EMPTY AUTHORIZED CHANGES

STRUCTURE	(+40)
Add structural beef-up required to support the rendezvous radar equipment.	+40
COMMUNICATION & RENDEZVOUS RADAR	(+120)
Add rendezvous radar equipment consistent with the LOR requirements.	+120
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TOTAL SERVICE MODULE WEIGHT EMPTY CHANGES	+160

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POTENTIAL WEIGHT CHANGES

COMMAND MODULE

ITEM	AIRFRAME 011	LOR SPACECRAFT
<u>CURRENT DESIGN CHANGES</u>		
<u>STRUCTURE</u>	(+144)	(+144)
Increase ablator consistent with current AVCO status. NAA is currently studying AVCO's ablator thicknesses and densities versus new heating rates.	+124	+124
Increase honeycomb bonding due to a change in adhesive bonding specification for the Apollo spacecraft requiring increases in the bonding thicknesses in the splicing areas.	+20	+20
<u>CREW SYSTEMS</u>	(+116)	(+116)
Revise attenuation shock struts to be compatible with the crew acceleration limits and incorporate lockouts to prevent stroking of shock struts during re-entry in order to reserve the full stroking for earth impact.	+28	+28
Reduce the trilox pads from three layers to two layers and delete worktable assembly per current requirements.	-3	-3
Increase spacesuits based on updating to current data. (U.L.)	+46	+46
Increase survival kit based on utilizing a NASA kit in lieu of an NAA kit. (U.L.)	+24	+24
Decrease flight kits based on redesign deleting sextants.	-6	-6
Decrease constant wear garments based on current requirements.	-3	-3
Increase thermal coveralls based on updating to current data.	+4	+4
Increase portable life support systems based on current Hamilton Standards weights.	+26	+26

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~~CONFIDENTIAL~~POTENTIAL WEIGHT CHANGES (CONTINUED)COMMAND MODULE

ITEM	AIRFRAME 011	LOR SPACECRAFT
<u>EARTH LANDING SYSTEM</u>	(+17)	(+17)
Increase main parachutes based on latest vendor information.	+17	+17
<u>COMMUNICATIONS</u>	(+7)	(+7)
Increase signal conditioner due to replacing dummy modules with active signal conditioning module for redundancy.	+7	+7
SUBTOTAL CURRENT DESIGN CHANGES	+284	+284

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**~~CONFIDENTIAL~~**POTENTIAL WIEGHT CHANGES (CONTINUED)COMMAND MODULE

ITEM	AIRFRAME 011	LOR SPACECRAFT
<u>MANDATORY CHANGES TO LOR</u>		
<u>STRUCTURE</u>		(+24)
Relocate forward pitch engines.		+4
Increase secondary structure due to adding electrical coldplates and redundant passages.		+10
Add provisions to allow extra vehicular activity thru the side hatch.		+10
<u>STABILIZATION & CONTROL</u>		(+30)
Increase wiring based on adding S-IV B control interface and body bending filters.		+5
Increase equipment due to miscellaneous humidity and EMI proofing.		+25
<u>CREW SYSTEMS</u>		(+61)
Addition of crew optics to provide a necessary visual alignment aid during docking.		+6
Increase egress accessories due to adding aids for extra vehicular activities.		+10
Add one PLSS based on current requirements for two in the Command Module.		+45
<u>ENVIRONMENTAL CONTROL</u>		(+20)
Provide the CO ₂ absorber elements with a bypass in order to attain minimum oxygen flow of 10 CFM/Man in 3.5 psia (suited) condition.		+10
Add free condensate control to minimize free water build up that could degrade electronic equipment.		+10

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POTENTIAL WEIGHT CHANGES (CONTINUED)

COMMAND MODULE

ITEM	AIRFRAME 011	LOR SPACECRAFT
<u>EARTH LANDING SYSTEM</u>		(+15)
Add a flotation bag system to provide an attitude equivalent to that of the Block I configuration.		+15
<u>INSTRUMENTATION</u>		(+56)
Add provisions to provide for S-IV B EDS interface.		+25
Add checkout provisions for the LEM in the stowed and docked position.		+31
<u>ELECTRICAL POWER</u>		(+151)
Add a DC to DC regulator.		+4
Increase provisions for 1300 wires 1600 pin umbilical (including wire).		+147
<u>COMMUNICATIONS</u>		(+38)
Increase equipment due to miscellaneous humidity and EMI proofing.		+25
Add a redundant S-Band power amplifier.		+6
Replace the scimitar antenna with the "S" band antenna.		+22
Transfer the VHF antenna to the Service Module.		-15
<u>CONTROLS AND DISPLAYS</u>		(+40)
Increase rendezvous radar control panel wiring.		+11
Modify control and displays for the lunar vehicle.		+29
SUBTOTAL MANDATORY CHANGES TO LOR		+435

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~~CONFIDENTIAL~~POTENTIAL WEIGHT CHANGES (CONTINUED)COMMAND MODULE

ITEM	AIRFRAME 011	LOR SPACECRAFT
<u>WEIGHT REDUCTIONS TO LOR</u>		
<u>STRUCTURE</u>		(-467)
Decrease ablator due to adding a full boost protective cover eliminating boost ablator and adding thermal paint reducing entry temperatures. (+80 -265)*		-185
Decrease ablator due to changing ablator thickness to criteria of 600°F at chute deployment.		-50
Decrease structure due to incorporating the following:		
Incorporation of a flat top heat shield.(+66 -73)*		-7
Attaching of LES tower at Sta. 100.		-68
Replacement of copper vent with beryllium.		-8
Utilization of titanium pork chop frames and stringers.		-41
Incorporation of single point parachute attachment.		-80
Reduction of factor of safety criteria from 1.5 to 1.4 in all areas requiring redesign.		-6
Replace rendezvous window well castings with honeycomb.		-11
Relocation of aft compartment equipment for center of gravity improvement.		-7
Removal of forward heat shield access door.		-5
Decrease lower equipment bay structure and coldplates based on the ring mounting concept design.(+60 -79)*		-19
Revise lower equipment bay due to deleting in-flight maintenance.		+20

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**~~CONFIDENTIAL~~**POTENTIAL WEIGHT CHANGES (CONTINUED)COMMAND MODULE

ITEM	AIRFRAME 011	LOR SPACECRAFT
<u>STABILIZATION & CONTROL</u>		(-56)
Decrease equipment and wiring due to repackaging for the ring mounted lower equipment bay concept and incorporating switchable redundant parts. (+10 -40)*		-30
Delete requirement for in-flight maintenance.		-26
<u>CREW SYSTEMS</u>		(-92)
Incorporate unitized crew couch design.		-70
Reduce food due to offloading for a 10 day in lieu of 14 day mission. (Useful Load)		-22
<u>ENVIRONMENTAL CONTROL</u>		(-28)
Reduce lithium hydroxide due to off loading for a 10 day in lieu of 14 day mission. (Useful Load)		-28
<u>EARTH LANDING SYSTEM</u>		(-30)
Incorporate Block II configuration utilizing a single point parachute attachment and repackaging of chutes.		-20
Reduce thrusters due to changing from four tension springs to two.		-10
<u>INSTRUMENTATION</u>		(-32)
Delete in-flight test system and depend on the caution and warning to give information for switching.		-32
<u>ELECTRICAL POWER</u>		(-175)
Decrease wiring and connectors based on reduced wire gauges and utilizing small connectors. (+105 -260)*		-155
Repackage post-landing batteries.		-20

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POTENTIAL WEIGHT CHANGES (CONTINUED)

COMMAND MODULE

ITEM	AIRFRAME 011	LOR SPACECRAFT
<u>COMMUNICATION</u>		(-118)
Decrease equipment and wiring due to repackaging for the ring mounted lower equipment bay concept.		-85
Decrease equipment due to deleting requirement for in-flight maintenance.		-33
<u>CONTROLS AND DISPLAYS</u>		(-11)
Delete main display computer keyboard and utilize LEB computer control only.		-25
Decrease main display panel due to eliminating subpanels and display by increasing time sharing of displays. (+24 -10)*		+14
<u>SCIENTIFIC EQUIPMENT</u>		(-170)
Remove from Lower Equipment Bay.		-35
Remove from Right Hand Equipment Bay.		-135
SUBTOTAL WEIGHT REDUCTIONS TO LOR		-1179
Due to lack of realistic design data, a contingency weight allowance is included in accordance with the May Block II Briefing to NASA.		+170
TOTAL POTENTIAL WEIGHT CHANGES - COMMAND MODULE	+284	-290

*Weight changes included in estimated changes to LOR.

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~~CONFIDENTIAL~~POTENTIAL WEIGHT CHANGESSERVICE MODULE

ITEM	AIRFRAME 011	LOR SPACECRAFT
<u>CURRENT DESIGN CHANGES</u>		
<u>STRUCTURE</u>	(+150)	(+150)
Increase engine mount and backup structure due to stiffness requirements.	+150	+150
<u>REACTION CONTROL SYSTEM</u>	(+12)	(+12)
Redesign RCS engine support housing to accommodate increased dynamic loads.	+12	+12
<u>PROPULSION</u>	(+210)	(+210)
*Increase SPS propellant based on new mixture ratio tolerance and trapped residuals.	+210	+210
SUBTOTAL CURRENT DESIGN CHANGES	+372	+372

*This increase applies only to Service Modules loaded to 39,100 pounds capacity. A lesser loading capacity will decrease this weight.

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~~CONFIDENTIAL~~POTENTIAL WEIGHT CHANGES (CONTINUED)SERVICE MODULE

ITEM	AIRFRAME 011	LOR SPACECRAFT
<u>MANDATORY CHANGES TO LOR</u>		
<u>STRUCTURE</u>		(+475)
Add meteoroid protection.		+475
<u>ENVIRONMENTAL CONTROL</u>		(+10)
Add provisions for LEM water transfer.		+10
<u>INSTRUMENTATION</u>		(+24)
Add provisions for LEM monitoring including wiring.		+24
<u>ELECTRICAL POWER</u>		(+98)
Increase wiring provisions for 1300 wires 1600 pin umbilical.		+98
<u>PROPULSION</u>		(+40)
Increase engine chamber outer wrap for passive thermal control.		+40
SUBTOTAL MANDATORY CHANGES TO LOR		+647

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POTENTIAL WEIGHT CHANGES (CONTINUED)

SERVICE MODULE

ITEM	AIRFRAME Oil	LOR SPACECRAFT
<u>WEIGHT REDUCTIONS TO LOR</u>		
<u>STRUCTURE</u>		(-650)
Decrease structure due to reducing factor of safety from 1.5 to 1.4 on all structures requiring redesign.		-25
Decrease insulation based on reduced thicknesses and densities.		-35
Shorten Service Module structure from 155 inches to 137 inches to be compatible with the shorter propellant tanks and refine Service Module design for weight savings.		-440
Decrease structure due to incorporating an SPS parallel feed system which enables relocation of the engine gimble actuators to the geometric axis and reduces the spring constant and stiffness requirement.		-125
Decrease structure due to removing hydrogen tank support shelf not required when utilizing one combined tank.		-25
<u>ENVIRONMENTAL CONTROL</u>		(-40)
Decrease cryogenic oxygen due to offloading for a ten day in lieu of fourteen day mission.		-40
<u>ELECTRICAL POWER</u>		(-531)
Increase cryogenic fluids based on current mission power requirements of 716 KWH.		+75
Decrease cryogenic tank based on utilizing a single hydrogen tank and a single oxygen tank in lieu of dual tanks.		-56

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POTENTIAL WEIGHT CHANGES (CONTINUED)

SERVICE MODULE

ITEM	AIRFRAME 011	LOR SPACECRAFT
<u>ELECTRICAL POWER (CONT'D)</u>		
Increase fuel cell reliability to require two fuel cells in lieu of three.		-310
Decrease cryogenic fluids due to offloading for a 10 day in lieu of 14 day mission.		-110
Decrease wiring and connectors based on reduced wire gauges and utilizing small connectors.		-130
<u>PROPULSION</u>		(-530)
Increase propulsion system due to incorporating an SPS parallel feed in lieu of a series feed.		+65
Decrease propellant and oxidizer tank gauges based on refined tank pressure regulation by utilizing precision valves which allow design for pressure relief at 225 psi rather than 240 psi.		-50
Decrease engines based on refined SPS engine design for weight reduction and greater reliability.		-100
Decrease propellant and oxidizer tanks due to shortening the tank for a 39,000 pound usable propellant.		-345
Decrease propellant and oxidizer tank gauges based on reducing helium quantity and allowing for P_c decay.		-100
SUBTOTAL WEIGHT REDUCTIONS TO LOR		-1751
Due to lack of realistic design data, a contingency weight allowance is included in accordance with the May Block II briefing to NASA.		+190
TOTAL POTENTIAL WEIGHT CHANGES - SERVICE MODULE	+372	-542

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~~CONFIDENTIAL~~POTENTIAL WEIGHT CHANGESLAUNCH ESCAPE SYSTEM

ITEM	AIRFRAME O11	LOR SPACECRAFT
Reduce tower insulation based on redefined boost and re-entry heating rates and raising the titanium allowable temperature to 800°F.	-75	-75
Add a full boost protective cover that will be jettisoned simultaneously with the LES.		+565
Reduce tower insulation based on shortened tower structure.		-50
Reduce tower structure due to optimization and shortening to interface with Command Module at X _C 100.0.		-90
TOTAL POTENTIAL WEIGHT CHANGES - LAUNCH ESCAPE SYSTEM	-75	+350

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~~CONFIDENTIAL~~POTENTIAL WEIGHT CHANGESADAPTER

ITEM	AIRFRAME 011	LOR SPACECRAFT
Add Service Module and LEM dispersal system.	+60	+60
TOTAL POTENTIAL WEIGHT CHANGES - ADAPTER	+60	+60

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~~CONFIDENTIAL~~DETAIL WEIGHT STATEMENTCOMMAND MODULESUMMARY

ITEM		CURRENT WEIGHT 5-1-64
<u>WEIGHT EMPTY</u>		8514
Structure	4727	
Stabilization & Control	226	
Guidance & Navigation	357	
Crew Systems	427	
Environmental Control	298	
Earth Landing System	627	
Instrumentation	262	
Electrical Power	580	
Reaction Control	330	
Communications	362	
Controls & Displays	318	
<u>USEFUL LOAD</u>		1536
Scientific Equipment	250	
Crew Systems	875	
Reaction Control	270	
Environmental Control	141	
GROSS WEIGHT		10050

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NORTH AMERICAN AVIATION, INC.



SPACE and INFORMATION SYSTEMS DIVISION

DETAIL WEIGHT STATEMENT
COMMAND MODULE
STRUCTURE

ITEM		CURRENT WEIGHT 5-1-64
<u>STRUCTURE</u>		
Inner Structure		(1058)
Forward Section		203
Honeycomb	63	
Frames, Rings, Hatches & Mechanism	57	
Fittings & Attachments	83	
Center Section		666
Honeycomb Panel	198	
Longerons, Frames & Rings	263	
Windows, Hatches & Mechanism	104	
Fittings & Attachments - H.S.	101	
Aft Section		189
Honeycomb Panel	110	
Ring & H.S. Attach	79	
Secondary Structure		(594)
RH Equipment Bay & Coldplates		90
LH Equipment Bay		84
Fwd. LH Equipment Bay		20
Rwd. RH Equipment Bay and Coldplates		19
Main Display Panel & Coldplates		64
Lower Equipment Bay & Coldplates		203
Aft Equipment Bay		65
Crew Area		5
Heat Shield Equipment Area		44
Heat Shield Substructure		(1435)
Forward Section		193
Honeycomb Panels & Closeouts	103	
Frames, Rings, & Access Doors	35	
Fittings, Attach & Mechanism	55	
Center Section		709
Honeycomb Panels & Closeouts	245	
Frames and Rings	116	
Access Doors, Windows & Hatch Covers	192	
Fittings, Mechanism & Attach. H.S.	132	
Air Vent	24	
Aft Section		533
Honeycomb Panels & Closeouts	360	
Frames & Rings	47	
Fittings & Attach H.S.	73	
Toroidal Assembly	53	
Ablation Material		(1273)
Forward Section		116
Center Section		529
Aft Section		628
Insulation		(195)
Separation Provisions and Attachments		(22)
LEM Docking		(150)
TOTAL STRUCTURE		4727

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~~CONFIDENTIAL~~DETAIL WEIGHT STATEMENTCOMMAND MODULESTABILIZATION AND CONTROL

ITEM	CURRENT WEIGHT 5-1-64
<u>STABILIZATION AND CONTROL</u>	
Lower Equipment Bay	(171.6)
Rate Gyro Package	7.5
Body Mounted Gyro Package	12.8
Electronic Control Package - Pitch	28.3
Electronic Control Package - Roll	28.6
Electronic Control Package - Yaw	28.9
Electronic Control Package - Auxiliary	28.8
Display/BMAG ECA Package	36.7
Spares - Lower Equipment Bay	(14.5)
Spare Gyro - BMAG (2)	2.0
Spare Gyro - Rate	.5
Spare Plug-In Module	12.0
Electrical Provisions	(39.9)
Wiring, etc.	39.3
SCS Power, Junction Box	.6
TOTAL STABILIZATION AND CONTROL	226.0

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~~CONFIDENTIAL~~DETAIL WEIGHT STATEMENTCOMMAND MODULEGUIDANCE & NAVIGATION

ITEM	CURRENT WEIGHT 5-1-64
<u>GUIDANCE AND NAVIGATION</u>	
Electronic Equipment	(230.2)
Inertial Measurement	42.0
Navigation Base	22.0
Computer	92.6
Power Servo Assembly	45.1
Coupling Display Unit	15.0
Bellows Assembly	13.5
Optical Equipment	(52.3)
Sextant	18.2
Telescope	13.8
Optical Base	16.7
Optical Eyepieces	3.6
Coolant Hoses	(1.0)
Electrical Provisions	(70.2)
Cabling MIT	43.2
Cabling NAA	27.0
Loose Stored Items	(3.3)
Film Cartridges (4)	1.8
Eye Relief Eyepiece	1.5
TOTAL GUIDANCE AND NAVIGATION	357.0

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~~CONFIDENTIAL~~DETAIL WEIGHT STATEMENTCOMMAND MODULECREW SYSTEMS

ITEM	CURRENT WEIGHT 5-1-64
<u>CREW SYSTEMS</u>	
Crew Accessories	(3.0)
Egress Accessories - Hatch	3.0
Crew Couch/Seat & Restraint System	(383.5)
Pad Assembly Couch	10.8
Harness Assembly - Restraint	12.0
Restraint Assembly - Rest Station	4.0
Restraint Assembly - Lower Equipment Bay	2.0
Sandal - Weightless Restraint	2.0
Structure - Lock & Release	265.7
Structure - Support & Attenuation	87.0
Window Filter Assemblies	(3.8)
Food & Associated Equipment	(9.4)
Shelf Assy. - Work/Food Preparation	1.9
Food Storage Boxes	5.0
Delivery Assy. - Water	2.5
Waste Management System	(2.7)
Supports	(.4)
Crew Equipment	(24.2)
Umbilical Assy.	17.9
Hose Assy - PLSS O ₂ Recharge	2.8
Electrical Umbilical - PGA	2.5
Constant Wear Garment Stowage	<u>1.0</u>
TOTAL CREW SYSTEMS	427.0

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~~CONFIDENTIAL~~DETAIL WEIGHT STATEMENTCOMMAND MODULEENVIRONMENTAL CONTROL SYSTEM

ITEM	CURRENT WEIGHT 5-1-64
<u>ENVIRONMENTAL CONTROL SYSTEM</u>	
Pressure Suit Circuit	(88.3)
Subcontractor Compressor, Heat Exchg., Val. & Cont.	70.8
Ducting, Conn., Clamps, & Compr. Sel. Sw.	15.5
CO ₂ Sensor	2.0
Water-Glycol Circuit	(68.8)
Subcontractor Res., Evaporator, Pump, Val. & Cont.	35.4
Water-Glycol	18.4
Plumbing & Glycol Pump Sel. Sw.	15.0
Pressure & Temp. Control	(19.1)
Subcontractor Heat Exchg., Blower, Val. & Cont.	16.7
Ducting & Cabin Blower Sel. Sw.	2.4
Oxygen Supply System	(17.2)
Subcontractor Val. & Cont.	5.2
Plumbing	4.5
Oxygen Surge Tank	7.5
Water Supply System	(27.5)
Subcontractor Potable & Waste Tanks	24.2
Plumbing	3.3
Subcontractor Common Items	(27.5)
Brackets, Plumbing, Elect. Wiring	13.0
Instrumentation	14.5
S&ID Common Items	(27.2)
Nitrogen Purge System	2.8
Supports	11.0
Electrical Provisions	9.8
Manual Control - Push Pull	3.6
Waste Management System	(22.4)
TOTAL ENVIRONMENTAL CONTROL SYSTEM	298.0

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~~CONFIDENTIAL~~DETAIL WEIGHT STATEMENTCOMMAND MODULEEARTH LANDING SYSTEM

ITEM	CURRENT WEIGHT 5-1-64
<u>EARTH LANDING SYSTEM</u>	
Parachute System	(513.5)
Drogue Chute System	72.2
Main Cluster	370.8
Pilot Chute System	24.8
Sequence Control	8.5
Attach Provisions	37.2
Location Aids	(5.3)
Forward Heat Shield Release System	(52.5)
Drogue Disconnect Installation	(9.6)
Electrical Pyrotechnic Initiation Provisions	(6.0)
Crushable Honeycomb - Impact Attenuation	<u>(40.1)</u>
TOTAL EARTH LANDING SYSTEM	627.0

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~~CONFIDENTIAL~~DETAIL WEIGHT STATEMENTCOMMAND MODULEINSTRUMENTATION

ITEM	CURRENT WEIGHT 5-1-64
<u>INSTRUMENTATION</u>	
Remote Equipment	(42.5)
Sensors	35.0
Nuclear Radiation Detection Provisions	1.5
TV Camera	4.5
TV Viewfinder	1.5
Lower Equipment Bay	(47.1)
PCM Unit No. 1	24.1
PCM Unit No. 2	23.0
Right Hand Bay Forward	(27.0)
Inflight Test System	
Comparators	6.8
Power Supply	3.2
Controls	5.0
Misc. Electronics	2.0
Chassis	4.0
Harness	5.0
Access Cable	1.0
Electrical Provisions	(145.4)
Inflight Test Electrical Provisions	15.0
Data Distribution Panel	2.3
Instrumentation Electrical Provisions	128.1
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TOTAL INSTRUMENTATION	262.0

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DETAIL WEIGHT STATEMENT

COMMAND MODULE

ELECTRICAL POWER

ITEM	CURRENT WEIGHT 5-1-64
 <u>ELECTRICAL POWER</u>	
Energy Source	(75.8)
Battery - Re-Entry (2)	44.2
Battery - Post Landing (1)	22.1
Battery - Pyrotechnic - Installation	8.0
Battery Vent System	1.5
 Power Conversion	 (121.0)
Inverter (3) & Control	117.0
Battery Charger & Controls	4.0
 Power Distribution & Control	 (123.7)
D-C Power Panel Assy	7.6
A-C Power Box Assy	10.5
Battery Circuit Breaker Panel	3.4
Lower Equipment Bay Panel	4.2
Terminal Distribution Panel (Bus)	9.6
Circuit Breaker Panel	4.7
Electrical Transmission (Wiring, Connectors, Cond., Sup.)	59.2
Ground Power Provisions	4.5
Power Control Panel Connectors	3.0
Installation Provisions	10.0
Phase Correcting Capacitor	6.0
Inverter Bus Selection Control	1.0
 Electrical Common Utility	 (253.0)
Electrical Transmission (Conn., Cond., & Sup.)	106.6
Right Hand Circuit Breaker Panel	17.1
Left Hand Circuit Breaker Panel	10.9
Lighting	2.5
Adapter Separation System	2.5
LES Separation System	15.1
Circuit Utilization Package	6.3
Sequencer	39.1
Installation Provisions	13.3
C/M to S/M Separation System Wiring & Hardware	9.2
SPS Electrical Provisions - S/M	19.3
RCS Electrical Provisions - S/M	11.1
 Lighting Equipment	 (6.5)
 TOTAL ELECTRICAL POWER	 580.0

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~~CONFIDENTIAL~~DETAIL WEIGHT STATEMENTCOMMAND MODULEREACTION CONTROL SYSTEM

ITEM	CURRENT WEIGHT 5-1-64
<u>REACTION CONTROL SYSTEM</u>	
Propellant System	(73.5)
Oxidizer System	37.2
Tanks & Expulsion Devices	15.0
Plumbing, Fittings & Insulation	11.4
Valves & Regulators	10.3
Sensors	.5
Fuel System	36.3
Tanks & Expulsion Devices	14.1
Plumbing, Fittings & Insulation	11.4
Valves & Regulators	10.3
Sensors	.5
Pressure System	(55.4)
Tanks (4500 psi)	9.5
Plumbing, Fittings & Insulation	4.8
Valves & Regulators	38.6
Sensors	2.5
Engine System	(132.0)
Engines	90.0
Nozzle Extension	42.0
Electrical Provisions	(36.7)
Dumping System	(32.4)
Valves & Supports	13.0
Controls & Electrical Provisions	12.0
Plumbing & Fittings	5.0
Miscellaneous	2.4
TOTAL REACTION CONTROL SYSTEM	330.0

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~~CONFIDENTIAL~~DETAIL WEIGHT STATEMENTCOMMAND MODULECOMMUNICATIONS

ITEM	CURRENT WEIGHT 5-1-64
<u>COMMUNICATIONS</u>	
Lower Bay	(242.8)
C-Band Transponder	22.8
Unified S-Band	30.9
S-Band Power Amplifier	17.5
VHF-FM Transmitter/HF Transceiver	15.4
VHF AM Trans. -Rec/VHF Rec. Bea.	15.1
Multiplexer	12.0
Signal Conditioner	40.0
Recorder	25.4
Audio Center	8.0
Premodulation Processor	14.2
Central Timing Equipment	8.0
Up Data Link and Provisions	24.5
VHF-HF Diplexer	1.7
VHF-UHF Diplexer	1.5
S-Band P.A. Spare Traveling Wave Tube	1.3
S-Band P.A. Spare Power Supply	4.5
Remote Equipment	(57.3)
VHF-HF Recovery Antenna & Transmission	11.4
C-Band Antenna & Transmission	11.7
2-KMC High Gain Antenna and Transmission	4.4
VHF-2 KMC Omni Ant., Trans. & Instl. Prov.	29.8
Electrical Provisions	(42.9)
Electrical Wiring	30.1
Data Distribution Panel	1.5
Coax	5.2
Connectors	6.1
Spares	(19.0)
TOTAL COMMUNICATIONS	362.0

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~~CONFIDENTIAL~~DETAIL WEIGHT STATEMENTCOMMAND MODULECONTROLS AND DISPLAYSCURRENT
WEIGHT
5-1-64

ITEM

MAIN DISPLAY PANEL

Main Display Panel Control Station	(67.6)
SCS Mode Select	3.0
Delta Velocity	3.1
Flight Director Attitude Indicator	11.1
Attitude Set and Gimbal Position Display	4.8
SPS Gimbal Actuator	.5
Entry Monitoring Indicator	23.0
Launch Vehicle Emergency Detection System C-1	4.7
Master Caution and Abort Lt.	.3
IFTS Switch	.1
Barometric Indicator Light	.1
Event Timer	1.5
Mounting Panels	2.4
Rendezvous Radar	13.0
Main Display Panel Center Station	(65.2)
Audio Panel	1.2
Abort Light	.2
Reaction Control	11.2
GMT Readout	.8
ECS Gages and Controls	6.6
Crew Safety Controls	1.6
High Gain Antenna Control	2.5
G & N Computer Keyboard	20.5
Radiation Displays	1.5
Cryogenic	4.2
Caution and Warning Display	4.8
Mounting Panels	10.1
Main Display Panel System Management Station	(31.5)
Communications Control Panel	4.0
Master Caution Lights	.2
Power Distribution	6.1
Fuel Cells Controls	4.7
Service Propulsion	8.9
IFTS Switch	.1
Oxygen Warning	.1
Mounting Panels	7.4
Main Display Panel RH Console	(10.5)
Bus Switches	5.7
Audio Panel	1.2
Lighting Control	1.6
Mounting Panels	2.0
Main Display Panel LH Console	(7.9)
Mission Sequence Controls	1.0
Lighting Control	1.6
Audio Panel	1.2
SCS Power Control	2.2
Mounting Panels	1.9

TOTAL MAIN DISPLAY PANEL (To be brought forward)

182.7

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~~CONFIDENTIAL~~DETAIL WEIGHT STATEMENTCOMMAND MODULECONTROLS AND DISPLAYS

ITEM	CURRENT WEIGHT 5-1-64
REMOTE EQUIPMENT	
Lower Equipment Bay	(50.8)
Lighting Control Panel	1.2
G & N Controls and Displays	49.6
Map and Data Viewer	8.3
Display and Control - Navigation	20.7
Display and Control - Computer	20.6
Left Hand Forward Equipment Bay	(3.0)
Clock	.8
Event Timer	2.0
Mounting Panel	.2
Crew Area Controls	(17.5)
Manual Control - Rotation	9.1
Manual Control - Translational	8.4
Caution and Warning Detector	(14.0) 14.0
Electrical Provisions	(50.0)
Electrical Wiring	49.3
SCS/G & N Display Junction Box	.7
<hr/>	
TOTAL REMOTE EQUIPMENT	135.3
TOTAL MAIN DISPLAY PANEL	182.7
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TOTAL CONTROLS AND DISPLAYS	318.0

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~~CONFIDENTIAL~~DETAIL WEIGHT STATEMENTCOMMAND MODULEUSEFUL LOAD

ITEM	CURRENT WEIGHT 5-1-64
<u>CREW SYSTEMS</u>	
Government Furnished Equipment	(672.6)
Pressure Garment Assembly (3)	60.6
Portable Life Support System (1)	42.0
Garments - Constant Wear	8.4
Biomedical Instrumentation	2.0
Personal Radiation Dosimeters	11.8
Thermal Coverall	19.8
Crew (50, 70, 90 Percentile)	528.0
Food and Associated Equipment	(82.0)
Food	67.5
Food Containers	12.5
Food Mouthpiece - Personal	2.0
Crew Accessories	(18.5)
Flight Kit Assy.	12.0
Light Assy. - Portable	3.0
Tool Set - Inflight Maintenance	3.5
Crew Equipment	(1.0)
Belt Assembly - Inflight Maintenance	1.0
Waste Management	(1.5)
Medical Equipment	(12.1)
Personal Hygiene Equipment	(15.6)
Provisions Assembly - Crew Survival	(66.6)
Personal Communications	(5.1)
<hr/>	
TOTAL CREW SYSTEM (To be brought forward)	875.0

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~~CONFIDENTIAL~~DETAIL WEIGHT STATEMENTCOMMAND MODULEUSEFUL LOAD

ITEM	CURRENT WEIGHT 5-1-64
<u>REACTION CONTROL</u>	(270.0)
Usable Propellant	225.0
Residual Propellant	44.0
Trapped - System	30.8
Mixture Ratio	2.7
Expulsion Efficiency	7.8
Loading Tolerance	2.7
RCS Helium	1.0
<u>ENVIRONMENTAL CONTROL</u>	(141.0)
Lithium Hydroxide	104.0
Activated Charcoal	3.8
Containers for LiOH & Charcoal	12.0
Oxygen - Re-Entry	3.7
Water-Earth Orbit Cooling & Drinking	3.5
Water-Boost Cooling	4.0
Water-Emergency Re-Entry Cooling	6.0
Chemical Disinfectant	4.0
<u>SCIENTIFIC EQUIPMENT</u>	(250.0)
TOTAL (This page)	661.0
TOTAL CREW SYSTEM (Brought forward from Page)	875.0
TOTAL USEFUL LOAD	1536.0

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~~CONFIDENTIAL~~DETAIL WEIGHT STATEMENTSERVICE MODULESUMMARY

ITEM		CURRENT WEIGHT 5-1-64
<u>WEIGHT EMPTY</u>		(7890)
Structure	2380	
Environmental Control	90	
Instrumentation	132	
Electrical Power	1449	
Propulsion	3079	
Reaction Control System	576	
Communications & Rendezvous Radar	184	
<u>USEFUL LOAD</u>		(2230)
Reaction Control	838	
Electrical Power	503	
Environmental Control	208	
Propulsion	681	
BURNOUT WEIGHT		10120
MAIN PROPELLANT		36970
GROSS WEIGHT		47090

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~~CONFIDENTIAL~~DETAIL WEIGHT STATEMENTSERVICE MODULESTRUCTURE

ITEM	CURRENT WEIGHT 5-1-64
<u>STRUCTURE</u>	
Basic Body Structure	(1689)
Honeycomb Panels	585
Frame and Rings	6
Access Doors	16
Fittings and Attach Parts	48
Radial Beams	373
Internal Partitions	37
Forward Bulkhead	167
Aft Bulkhead	327
RCS Panels	130
Secondary Structure	(185)
Tank Support Shelf	29
Engine Support Structure	54
Antenna Support Structure	50
Aft Heat Shield	52
Insulation	(299)
Separation Provisions and Attachments	(16)
Fairing - C/M to S/M	(161)
Miscellaneous	(30)
<hr/>	
TOTAL STRUCTURE	2380

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~~CONFIDENTIAL~~DETAIL WEIGHT STATEMENTSERVICE MODULEENVIRONMENTAL CONTROL SYSTEM

ITEM	CURRENT WEIGHT 5-1-64
<u>ENVIRONMENTAL CONTROL SYSTEM</u>	
Water-Glycol Circuit	(76.2)
Subcontractor Valves & Controls	10.5
Plumbing and Hardware	20.5
Water - Glycol	10.0
Space Radiator (Outer Skin)	35.2
Water Supply System	(6.6)
Plumbing and Hardware	6.6
Oxygen Supply System	(3.0)
Plumbing and Supports	3.0
Common Items	(4.2)
Supports	2.9
Wiring	1.3
<hr/>	
TOTAL ENVIRONMENTAL CONTROL SYSTEM	90.0

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~~CONFIDENTIAL~~DETAIL WEIGHT STATEMENTSERVICE MODULEINSTRUMENTATION

ITEM	CURRENT WEIGHT 5-1-64
INSTRUMENTATION	
Instrumentation Sensors	(29.0)
Electrical Provisions	(96.0)
Supports	(5.0)
Radiation Detection	(2.0)
<hr/>	
TOTAL INSTRUMENTATION	132.0

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~~CONFIDENTIAL~~DETAIL WEIGHT STATEMENTSERVICE MODULEELECTRICAL POWER

ITEM	CURRENT WEIGHT 5-1-64
<u>ELECTRICAL POWER</u>	
Fuel Cell Power System	(1223.5)
Fuel Cell Power Pack (Incl. Mount Instrumentation)	738.9
Intermodular - Radiator Plumbing	47.5
Fuel Cell Module Mount Attach	1.1
Fuel Cell H ₂ System	
Subcontractor Components	151.6
Plumbing and Valves	5.5
Fuel Cell and ECS O ₂ System	
Subcontractor Components	176.8
Plumbing and Valves and Supports	31.7
Water Glycol - Fuel Cell Heat Transfer System	7.0
Elect. Wiring - Supercritical Gas	8.7
Space Radiator (Outer Skin)	40.5
Fuel Cell Module Stabilization Webs	2.9
Fuel Cell Plumbing Supports	6.0
Valve Module Control Box (Cryogenic Gas)	5.3
Power Distribution	(96.5)
Electrical Transmission	65.7
Power Distribution Box	30.8
Electrical Common Utility	(129.0)
Electrical Transmission	47.6
Sequencer	28.0
Adapter Separation System	1.4
C/M to S/M Separation System	22.5
Pyrotechnic Initiation	12.0
Provisions	10.1
LES Separation System Wiring & Hardware	7.4
TOTAL ELECTRICAL POWER	1449.0

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DETAIL WEIGHT STATEMENT

SERVICE MODULE

MAIN PROPULSION

ITEM	CURRENT WEIGHT 5-1-64
<u>MAIN PROPULSION</u>	
Propellant Systems	(1395.0)
Oxidizer System	779.3
Tanks & Doors	557.0
Skirts	59.8
Plumbing, Fittings & Insulation	53.0
Valves	4.5
Quantity Indication	25.5
Mixture Ratio Control	14.0
Supports - Plumbing & Equipment	43.5
Retention Reservoir	22.0
Fuel System	615.7
Tanks & Doors	458.0
Skirts	33.2
Plumbing, Fittings & Insulation	42.0
Valves	4.5
Quantity Indication	25.5
Supports - Plumbing & Equipment	31.5
Retention Reservoir	21.0
Pressure System	(925.0)
Tanks (4400 psi)	784.0
Tanks Supports	30.0
Plumbing, Fittings & Insulation	24.0
Valves, Regulators & Heat Exchanger	49.0
Supports - Plumbing & Equipment	38.0
Engine System	(727.0)
Engine	702.0
Closeouts - Throat to S/M	25.0
Electrical Provisions	(32.0)
TOTAL MAIN PROPULSION SYSTEM	3079.0

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~~CONFIDENTIAL~~DETAIL WEIGHT STATEMENTSERVICE MODULEREACTION CONTROL

ITEM	CURRENT WEIGHT 5-1-64
<u>REACTION CONTROL SYSTEM</u>	
Propellant Systems	(181.4)
Oxidizer System	92.1
Tanks & Expulsion Devices	34.4
Plumbing, Fittings & Insulation	8.5
Valves & Regulators	12.0
Sensors	3.0
Supports	18.2
Quantity Gaging	16.0
Fuel System	89.3
Tanks & Expulsion Devices	31.6
Plumbing, Fittings & Insulation	8.5
Valves & Regulators	12.0
Sensors	3.0
Supports	18.2
Quantity Gaging	16.0
Pressure System	(128.0)
Tanks (4500 psi)	19.0
Plumbing, Fittings & Insulation	6.0
Valves & Regulators	76.0
Sensors	7.0
Supports	20.0
Engine System	(155.2)
Engines	75.2
Reflectors & Insulation	80.0
Structural Provisions	(80.0)
Electrical Provisions	(31.4)
<hr/>	
TOTAL REACTION CONTROL SYSTEM	576.0

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~~CONFIDENTIAL~~DETAIL WEIGHT STATEMENTSERVICE MODULECOMMUNICATIONS & RENDEZVOUS RADAR

ITEM	CURRENT WEIGHT 5-1-64
<u>COMMUNICATIONS</u>	(64.0)
Remote Equipment	40.0
Gimbal - High Gain Antenna	12.2
Earth Sensor - High Gain Antenna	12.0
High Gain Antenna	4.8
Locking Provisions - High Gain Antenna	3.0
Boom - High Gain Antenna	8.0
Electrical Provisions	23.0
Wiring - Common Utility	14.0
Coax & Connectors - High Gain Antenna	9.0
Supports	1.0
<u>RENDEZVOUS RADAR</u>	(120.0)
Rendezvous Equipment	69.8
Radar Package	30.0
X-Band Dish Ant., Trans. & Sup.	17.8
Antenna Boom	10.0
Antenna Actuation Mechanism	10.0
Diplexer	2.0
Transponder Equipment	28.6
Transponder	10.0
X-Band Flush Mntd. Omni Ant. (3)	3.0
X-Band Trans. & Supports	12.6
X-Band Power Divider	1.0
Diplexer	2.0
Supports & Cooling Provisions	15.6
Rendezvous Equipment	9.6
Transponder Equipment	6.0
Electrical Provisions	6.0
Rendezvous Equipment	3.0
Transponder Equipment	3.0
TOTAL COMMUNICATION & RENDEZVOUS RADAR	184.0

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~~CONFIDENTIAL~~DETAIL WEIGHT STATEMENTSERVICE MODULEUSEFUL LOAD

ITEM		CURRENT WEIGHT 5-1-64
REACTION CONTROL		(838.0)
RCS Propellant		835.0
Usable	790.0	
Residual	45.0	
Trapped System	4.0	
Mixture Ratio	9.0	
Expulsion Efficiency	24.0	
Loading Tolerance	8.0	
RCS Helium		3.0
ELECTRICAL POWER (Normal Mission)		(503.0)
Hydrogen - Supercritical Gas		58.5
Usable (Electrochemical Incl. Tolerance)	46.0	
Unusable (Residual & Instrument Error)	3.2	
Emergency Provisions	4.7	
Expend (Leakage & Purge)	4.6	
Oxygen - Supercritical Gas		444.5
Usable (Electrochemical Incl. Tolerance)	377.0	
Unusable (Residual & Instrument Error)	17.5	
Emergency Provisions	44.0	
Expend (Leakage & Purge)	6.0	
ENVIRONMENTAL CONTROL (Normal Mission)		(208.0)
Oxygen - Supercritical Gas		208.0
Usable (Metabolic)	76.5	
Unusable (Residual & Instrument Error)	9.1	
Emergency Provisions	25.3	
Expend (Leakage, LEM, PLSS, Repress.)	97.1	
PROPULSION		(681.0)
Main Propulsion Helium		99.0
Main Propellant Residuals		582.0
Trapped - System	225.0	
Trapped - Engine	67.0	
Mixture Ratio Tolerance	100.0	
Loading Tolerance	190.0	
TOTAL USEFUL LOAD (Less Main Propellant)		2230.0

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~~CONFIDENTIAL~~DETAIL WEIGHT STATEMENTLAUNCH ESCAPE SYSTEMSUMMARY

ITEM	CURRENT WEIGHT 5-1-64
<u>LAUNCH ESCAPE SYSTEM</u>	
Structure	(1314)
Tower Assy	301
Escape Motor Skirt	208
Canard	560
Nose Cone	35
Attaching Parts	14
Tower Insulation	186
Skirt Insulation	10
Separation Provisions	(13)
Ballast	(639)
Propulsion	(5349)
Escape Motor	4774
Jettison Motor	434
Jettison Motor Skirt	92
Pitch Control Motor	49
Electrical Power	(85)
C/M Boost Protection Cover	(185)
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TOTAL LAUNCH ESCAPE SYSTEM	7585

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~~CONFIDENTIAL~~DETAIL WEIGHT STATEMENTADAPTERSUMMARY

ITEM	CURRENT WEIGHT 5-1-64
<u>ADAPTER</u>	
Structure	(3405)
Basic Body Structure	
Honeycomb Panels	2279
Longerons	46
Frames & Rings	306
Access Doors	50
Fittings & Attaching Parts	60
Secondary Structure	
LEM Supports	32
Insulation	218
Separation Provisions & Attach	334
Miscellaneous	80
Electrical Provisions	(70)
	<hr/>
TOTAL ADAPTER	3475

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